EXHIBIT 3

BUFFALO BAYOU, TEXAS

DEFINITE PROJECT REPORT

WAR DEPARTMENT, CORPS OF ENGINEERS, U. S. ARMY

U. S. ENGINEER OFFICE, GALVESTON, TEXAS

JUNE 1, 1940

CONSTRUCTION DRAFTING SECTION

BUFFALO BAYOU, TEXAS

DEFINITE PROJECT REPORT

U. S. Engineer Office,
Galveston, Texas
June 1, 1940

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WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
GALVESTON, TEXAS

June 1, 1940

Subject: Definite project plan for flood control on Buffalo Bayou, Texas.

To: The Chief of Engineers, U. S. Army, Washington, D. C., (through The Division Engineer, Gulf of Mexico Division, New Orleans, Louisiana.)

1. In accordance with Circular Letter R. & H. No. 19, April 12, 1939, I submit the following definite project report for the control of floods on Buffalo Bayou, Texas. This project plan is in furtherance of the project outlined in House of Representatives Document No. 456, 75th Congress, 2nd Session, authorized by the River and Harbor Act, approved June 20, 1938, and amended by the Flood Control Act, approved August 11, 1939.

2. Certain features of the project plan, which are proposed and developed in this report, have the approval of the Office, Chief of Engineers, U. S. Army, and the Harris County Flood Control District, representing local interests. By letter, dated February 23, 1940, Office, Chief of Engineers to the Division Engineer, Gulf of Mexico Division, Subject: "Flood Protection Plan for Houston (Buffalo Bayou)", approval was given to the following basic features:

"(a) Federal participation for construction costs not to exceed $9,000,000.

"(b) The construction of the White Oak Detention Reservoir and Diversion Canal.

"(c) The construction of the twin reservoirs in the vicinity of Addicks.

"(d) The reservoirs as in (b) and (c) above, to be constructed so as to be safe against the maximum probable storm, and the north diversion canal to be of such capacity as to prevent the necessity for discharging flood flows from White Oak Reservoir through the City of Houston.

"(e) The construction of a Diversion Canal from the twin reservoirs to Galveston Bay to be built when local authorities give assurances that they will pay the construction cost thereof."

3. The Harris County Flood Control District agreed, by resolution passed and approved May 6, 1940, by the Commissioners' Court of Harris County, Texas, acting in its capacity as the governing authority of the Harris County Flood Control District:

"(2) To take such measures as may be necessary to establish and enforce building lines as approved by the Secretary of War for the protection of the floodway areas against further encroachment upon existing streams;

"(3) To prevent further dumping of waste materials upon the banks of the existing streams within the building lines to be established;

"(4) To remove or finance the removal of obstructions, now estimated at approximately $200,000;

"(5) That the entire project is susceptible of stage development both as to construction and financing; that the construction of the North and Central Canals, and their appurtenant works, shall be considered as the first stage; that the construction of the South Canal, and its appurtenant works, shall be considered as the second stage; that Stage 1 shall be the first stage to be constructed; that the Harris County Flood Control District will have available and will furnish such local funds for the

construction of the items embraced in the first stage of the agreed joint plan as may be required of the District in excess of the construction cost to be borne by the United States Government, the proportion of the Government being presently fixed at $9,000,000 toward the construction costs of the entire plan; the Harris County Flood Control District will furnish said local funds for the payment of construction costs of Stage 1 or will place the same in escrow or will deposit said funds with the United States Government as may be required from time to time, in such proportions as the Government may desire.

"(6) That the construction of the South Canal and appurtenant works shall be undertaken as Stage 2 of the joint plan and in such proportions of joint contribution between the District and the Government as may be agreed upon when funds are available for its construction."

4. The project plan contained in this report, is, therefore, a joint plan and is acceptable, in principle, to both local interests and the U. S. Engineer Department. It is a plan which is susceptible of stage development, with ultimate construction to provide for complete control of floods on the Buffalo Bayou watershed and the protection of the city of Houston, Texas, and the Houston Ship Channel against the estimated probable maximum storm. The Harris County Flood Control District has given assurances required by House of Representatives Document No. 456, 75th Congress, 2nd Session, and, in addition, has given assurances with respect to local financing of the north and central canals at this time as the first

stage of construction of this plan.

5. Description.- Buffalo Bayou rises in eastern Waller County and western Harris County, flows generally eastward in a narrow and tortuous channel 75 miles long, passing through the city of Houston, and enters the San Jacinto River 9 miles above Galveston Bay. The lower reaches of the bayou have been improved as part of the Houston Ship Channel, which affords deep-draft ocean navigation to extensive terminal developments in and below Houston. The authorized project for improvement of the ship channel provides for a depth of 34 feet, with appropriate widths, from deep water in Galveston Bay to and in the Houston Turning Basin. The project provides also for a light-draft channel for the accomodation of barge traffic in Buffalo Bayou to the mouth of White Oak Bayou at Main Street, Houston, 6½ miles above the turning basin.

6. The watershed of Buffalo Bayou lies entirely within the Gulf Coast Prairie, a broad, almost featureless plain. The land surface rises gently toward the northwest with a slope of from 3 to 7 feet to the mile. Irregularities in the surface topography are confined almost entirely to the valleys cut by the streams. Cover growth in this basin consists of coarse native grasses, except along the stream banks which are usually quite heavily wooded.

7. Surface soils in the Buffalo Bayou region are outcrops of the Lissie and Beaumont formations belonging to the Quaternary system and consist of Katy fine sand loam and Lake Charles clay. Both formations are poorly drained and in the natural state do not per-

mit much percolation of surface water. Several drainage districts have been organized in this region to improve these lands for agricultural use.

8. The streams in the Buffalo Bayou watershed have little or no flow during a considerable portion of the year, but are subject to high flood stages due to surface run-off during storm periods. The stream channels are small. The divides between drainage areas are not definitely defined. During heavy rainstorms, comparatively frequent in this area, there is a general overflow along the banks of the streams and an overflow over the divides southward from one stream to the next.

9. Buffalo Bayou flows through the center of the city of Houston and is joined in the commercial district of the city by White Oak Bayou. Brays Bayou also enters the main stream within the city and Sims Bayou forms the southeastern boundary of the city. Brays Bayou, Sims Bayou, and the upper reaches of White Oak Bayou pass through residential sections where development generally has not extended to the banks. Buffalo Bayou and the lower part of White Oak Bayou traverse the business section of the city. The increasing value of lands in this commercial area has resulted in encroachment upon the flood plain of Buffalo Bayou by building adjacent to the channel and even over it. Numerous industries have located on the Houston Ship Channel and its light-draft section, and many of these are affected directly by floods produced in Buffalo, White Oak, and Brays Bayous.

10. Storms of 1929 and 1935.- Six major floods have occurred in Buffalo Bayou since 1854, but reasonably accurate information as to flood flow is available only for those of May 1929 and December 1935. During the former, the indicated peak discharges from the 369.6 square miles of the Buffalo Bayou watershed above the mouth of White Oak Bayou, and from the White Oak Bayou basin of 112.9 square miles were 19,000 and 11,500 cubic feet per second, respectively, and the peak flow of Buffalo Bayou below the junction with White Oak Bayou was 30,500 cubic feet per second. The corresponding discharges during the flood of 1935 were 40,000 cubic feet per second in Buffalo Bayou above White Oak Bayou, 16,750 cubic feet per second in White Oak Bayou, and 53,000 cubic feet per second in the channel between the mouth of White Oak Bayou and the turning basin of the Houston Ship Channel.

11. Property losses within the city during the flood of 1929 were reported to total $1,592,000. The flood of 1935 caused the loss of eight lives and a property damage estimated at $2,528,000. Commerce within the city was disrupted. A serious fire and health hazard existed. Utilities were interrupted. The Port of Houston was idle for a period of three days because of excessive currents in the ship channel and further delays were caused by silt deposits. Recent economic surveys made by this office indicate that, due to the rapid growth of the city and of the port facilities, a flood similar to the one of 1935 now would cause considerably more damage than it did five years ago and property losses probably would ex-

ceed $3,600,000. Damage summation and stage damage curves are shown on Plate 12, in the folio of drawings accompanying this report.

12. The rainfall for the 1929 storm varied from 6 to 12 inches over the White Oak Bayou and Buffalo Bayou basins. The flood of 1935 resulted from a 3-day rainfall which averaged about 15 inches over these basins and which reached a peak of 20.8 inches near Westfield, Texas, about 18 miles from Houston. Isohyetal maps of these two storms are included in the folio of drawings as Plates 5 and 6.

13. The Design Storm.- The Buffalo Bayou watershed is in an area subject to all of the circumstances making possible large storms. The Westfield storm of December 1935 was the most intense storm to visit the basin during the period of record. However, had the 1935 Westfield storm been centered over the basin, it would have produced a more severe flood than the one that actually occurred. There is no evident meteorological reason why the storm could not have centered over the basin. A careful study of the isohyetal maps of past storms indicates that only chance has prevented the occurrence of a storm over the basin much larger than the 1935 storm centered at Westfield. The storm showing the greatest depth of rainfall over a large area, of record in the United States, occurred in 1899 at Hearne, Texas, only 90 miles from Houston, under meteorological conditions that could be approximated closely over the Buffalo Bayou watershed. The isohyetal map of this storm is included as Plate 7 of the folio of drawings.

14. A detailed study of the rainfall possibilities in the Buf-

falo Bayou area was made by this district and forwarded to the Office, Chief of Engineers, by letter of December 13, 1938, subject: "Special Hydrology Report." The Special Hydrology Report was reviewed by the Office, Chief of Engineers, and the Hydrometeorological Division of the Weather Bureau, and the conclusion was reached that the maximum probable storm which might occur over the Buffalo Bayou basin was a transposition of the Hearne storm of June 28 - July 1, 1899, distributed as shown on Plate 8. Should such a storm visit the area, the average rainfall over the basin would be in excess of 27 inches, almost twice the average of 15 inches that produced the record flood of 1935. The storms referred to in this and the preceding paragraphs are discussed in the appendix, "Bases of Design", which is included with this report.

15. Peak Flows Produced by the Design Storm.- The design storm would produce the most disastrous peak flows if centered over or near the South Mayde Creek basin. Table 1 shows the resulting probable peak discharges at various points in the city of Houston, Texas. The flows shown in this table are those which would be produced provided that overflows from one drainage basin into the next were prevented. Considerable overflow would take place under present conditions, so that these figures represent potential flows:

TABLE I.

PEAK FLOWS PRODUCED BY THE DESIGN STORM

Location	Peak flow in c.f.s.
White Oak Bayou above Little White Oak Bayou	22,700
White Oak Bayou at mouth	27,600
Buffalo Bayou above mouth of White Oak Bayou	84,700
Buffalo Bayou below mouth of White Oak Bayou	104,400

16. Protection Desired by Local Interests.- The development of a workable engineering plan for any flood control project on Buffalo Bayou and the Houston Ship Channel is dependent upon the cooperation and coordination of local interests to the extent prescribed by the federal laws authorizing the project. Therefore, the ultimate plan for a project of this magnitude must be one susceptible of stage development, with divisions in the construction stages limited in extent to the ability of local interests to finance their participation in each stage.

17. The members of the Advisory Committee of Engineers appointed by the Harris County Flood Control District to review plans for flood control, express themselves as satisfied with protection against a storm which would develop run-offs 50 percent greater than those following the Westfield storm of December 6-8, 1935. In their opinion, the probability of the occurrence on the Buffalo Bayou basin of a storm as severe as the June-July 1899 Hearne storm is very remote, and while ultimate protection against such a storm is desirable,

the initial stage of the construction should provide protection against a lesser flood.

18. Peak Flows Produced by the 1935 Storm + 50%.- The peak flows, which would be produced by a storm located where the 1935 storm was centered and 50 percent greater in intensity than the 1935 storm, are shown for various points in the channels in Houston in Table II following. These flows are based on the assumption that no overflow would occur, and are subject to the same qualification given for Table I.

TABLE II.

PEAK FLOWS PRODUCED BY THE 1935 STORM INCREASED 50%

Location	Peak flow in c.f.s.
White Oak Bayou above Little White Oak Bayou	19,300
White Oak Bayou at mouth	23,500
Buffalo Bayou above mouth of White Oak Bayou	60,000
Buffalo Bayou below mouth of White Oak Bayou	79,500

19. Project Plan.- Enlargement and rectification of the channels of the Buffalo and White Oak Bayous, to establish capacity for the maximum probable crest discharges, would involve excessively large quantities of excavation, the alteration of many of the present bridges or their replacement by larger and more expensive structures, and the construction of special works to protect the Houston Ship

Channel from the deposition of silt during floods. Therefore, the final flood control plan must be one whose basic principle is regulation or diversion. With either regulation or diversion, the plan must include either detention or interception dams, or both, located above the city.

20. Plans for regulation are limited by the scarcity of suitable reservoir sites on the tributaries and the headwaters of Buffalo Bayou. Physical limitations at available sites require regulated outflows which are so large that, with the discharges from the uncontrolled areas below these dam sites, they would necessitate considerable work of channel enlargement and rectification below the dams.

21. Plans for diversion are limited by the topography and by the location of the city of Houston, the Port of Houston, and the developments outside the city proper, so that any diversion must be long and consequently expensive. In a system of diversion, the channel, or channels, provided must have sufficient capacity to carry the peak flows whereas with a combination of regulation and diversion the capacity only need be adequate to take the regulated flows.

22. Analyses of the detailed plans and studies made in the formulation of the flood-control plan presented in this report would indicate the complex nature of the various construction and financial features which were balanced and coordinated. The lack of agreement and the diversity of interests existing between various lo-

cal bodies and individuals concerned in securing protection against damage from floods complicated the problem further. In developing the many features of a cooperative undertaking of this magnitude, analyses based on engineering feasibility and cost alone could not be adhered to strictly. Local cooperation for financing the work and the desires of local interests necessitated considerable modifications of any such analyses.

23. Principal Features of the Project Plan.- Studies indicate that a system of reservoirs is basic and that one or more diversions from these reservoirs would be economical. The following plan, hereinafter designated as the Project Plan, typifies such a detention and diversion system. (See Plate 13).

24. The Project Plan has for its principal features:

a. Reservoir on White Oak Bayou, above the city limits, of such magnitude as to prevent flood run-off from the upper watershed of this stream, including the run-off from the maximum probable storm (design storm of 31.4 inches) from entering the city. A small conduit is proposed to permit low flows to pass down the channel for flushing purposes.

b. Bypass Channel to divert to Buffalo Bayou the small amount of run-off that is produced on the portion of the Brickhouse Gully watershed which would lie outside the White Oak Dam and otherwise would be undrained.

c. North Canal to divert the flood waters, entering the reservoir on White Oak Bayou, across the watersheds of Halls and

Greens Bayous, into the San Jacinto River.

d. Levee, north of Katy, Texas, to prevent overflow from the Mound and Cypress Creek basins into the Addicks Reservoir.

e. Twin Reservoirs at Addicks and Barker on Buffalo Bayou and tributaries, of such magnitude as to limit the run-off produced by the maximum probable storm (design storm of 31.4 inches) to a maximum total regulated discharge of about 15,000 cubic feet per second.

f. Rectification of Buffalo Bayou, from the Twin Reservoirs to the entrance of the South Canal, to accomodate the maximum outflow from these reservoirs.

g. Interception Dam on Buffalo Bayou west of the city limits, to divert flood flows from this bayou into a south canal. A small conduit is proposed to permit low flows to pass down the channel for flushing purposes.

h. South Canal of sufficient capacity to take the discharge from the twin reservoirs and a large portion of the flows from the uncontrolled areas, west and south of it, to Galveston Bay near Red Bluff.

i. Removal of Encroachments in the Buffalo Bayou Channel within the city to provide protection against the run-off which would be produced, below the White Oak Reservoir and the Interception Dam for the South Canal, by a storm as large as the 1935 storm increased 50 percent.

25. The design storms referred to in the preceding paragraph

are discussed in the appendix, "Bases of Design". Detailed discussions of the hydraulics, geology and soil data, and other factors governing the design of the project works also are contained in that appendix.

26. Types of Structures and Engineering Features.- The proposed detention reservoir on White Oak Bayou is to be formed by an impervious, rolled earth-fill dam located just below the mouth of Brickhouse Gully, which is about 2½ miles north and west of the city limits of Houston, Texas. One wing of the dam would extend up the left bank of White Oak Bayou. The other would extend along the right bank of Brickhouse Gully to a point about 1,500 feet from Federal Highway 290, cross Brickhouse Gully, and then parallel that highway for a distance of about 7,500 feet. The dam and pertinent features are shown on Plate 14. The length of the dam would be about 24,970 feet, but for 22,070 feet of this length, the height of the structure would not exceed 20 feet. A crown width of 15 feet and a crest at elevation 90.0 feet above mean sea level are proposed for the entire length of the embankment. The height of the dam at its maximum section would be about 35 feet, the foundation being at elevation 55.0 and the crest at elevation 90.0 M.S.L. Side slopes of 1 on 4 are proposed for the embankment material lying below elevation 70.0 M.S.L. Slopes of 1 on 3 are proposed on the wing dams and that portion of the embankment above elevation 70.0 M.S.L. It is proposed to protect the upstream face of this embankment with three inches of articulated concrete paving from crest elevation 90.0 to elevation

77.0, or to ground surface between stations 40/00 to 223/00. The use of riprap for this slope protection would be uneconomical and impracticable as suitable material for this purpose would have to be shipped in by rail and rehandled by truck.

27. Subsurface investigations by earth auger borings show the foundation for the dam to consist of sand and clay with some silt. Test borings to determine the availability of suitable embankment materials indicate, in general, that materials from borrow areas adjacent to the dam site could be used. Plan, profile and logs of these auger borings are shown on Plate 19. Further discussions of foundation and borrow-area materials are included in the appendix "Bases of Design". Curves showing mechanical analyses and results of shear tests of samples of foundation materials and materials from proposed borrow pits are shown on Plates 20 and 21. Detailed topography of the dam site is shown on Plates 22 to 35, inclusive.

28. In accordance with the desires of local interests, a conduit is proposed through the dam for passing low flows down White Oak Bayou channel for flushing purposes. This conduit would consist of concrete head walls and precast concrete pipe with seep rings. This conduit would discharge into a concrete stilling basin as shown on Plate 37. A maximum flow of about 500 cubic feet per second would pass through this conduit under the worst possible storm conditions. As requested by local interests, the remainder of the run-off produced on the White Oak Bayou watershed above this detention dam would be routed through an excavated channel to the San Jacinto River. This

channel, hereinafter referred to as the North Canal, is to be of sufficient capacity to discharge the flood flows produced by the maximum probable storm centered at its most unfavorable position on this watershed. The small amount of run-off that is produced on the portion of the Brickhouse Gully watershed, lying outside the dam, would be diverted to Buffalo Bayou by the Bypass Channel, as shown in detail on Plates 38 to 44, inclusive.

29. A recurrence of the 1935-Westfield storm would produce a pool elevation of 78.3 M.S.L. in the White Oak Reservoir. The 1935 storm increased 50 percent and transposed and centered over the area above the reservoir would increase the pool to elevation 83.0. The pool elevation which would be produced by the maximum probable design storm (31.4 inches) centered on the watershed would be elevation 85.2 M.S.L., which would be equivalent to a run-off of 6.4 inches from the 71.7 square miles above the dam. The crest of dam at elevation 90.0 M.S.L. would provide 5 feet of freeboard above the pool of the maximum probable storm. Additional protection, against wave action under design storm conditions, is provided for the embankment between stations 65/00 and 209/00 by the addition of a parapet with top at elevation 92.5, as shown in detail on Plate 86. Area and capacity and cost-discharge curves for the proposed reservoir are included on Plate 15. Channel rectification and clearing would be necessary along White Oak Bayou within the reservoir area.

30. The design storm pool, at elevation 85.2, has an area of 4,280 acres. It is proposed to purchase the surface rights of this

land in fee simple as it is being developed rapidly into small farm tracts, subdivisions, and residential plots, owing to its convenience to the city of Houston. Acquisition to this design-storm pool level is considered advisable, as future development of the entire area appears probable, and, with a pool at elevation 85.2 which can be expected to occur at least once in the life of the project, flooding damages may be expected to exceed greatly the present value of the land.

31. The main line of the Burlington-Rock Island Railroad traverses the proposed White Oak Reservoir area and dam site. The present roadbed would be abandoned and the track relocated, as shown on Plate 16. A maximum grade of 0.5 percent and two horizontal curves of one degree and two degrees respectively, are proposed on the final alignment.

32. Four surfaced county roads cross the proposed site of the embankment. These roads would be carried over the dam on earth fill approaches or ramps having grades of 5 percent or less. Sections of all of the roads in the reservoir area would be flooded with a recurrence of the 1935 storm. However, all of these roads are inundated under present conditions from storms of that intensity, and the frequency of flooding would not be increased materially by the construction of the White Oak Dam and its outlet works. Moreover, the lands surrounding the proposed area to be acquired by the U. S. Government are served by Federal Highway 290 and the West Montgomery Road.

33. As previously stated, all of the run-off produced on the watershed above the White Oak Dam would be carried by the North Canal across Halls Bayou and Greens Bayou watersheds and discharged into the San Jacinto River. The selected route of this canal is shown on Plate 45. The plan, profile, and logs of borings are shown on Plates 46 to 53, inclusive.

34. The design capacity of the North Canal from its beginning on White Oak Bayou to Greens Bayou is 22,000 cubic feet per second, with a water surface varying from 2.0 to 15.0 feet below the natural ground surface and an average water depth of about 24 feet. In this reach, the channel section would have a bottom width of 25 feet. Side slopes of 1 on 2 would be provided and paved with four inches of reinforced concrete to an elevation of three feet above the design storm water surface.

35. It is proposed to increase the design capacity of the North Canal to 32,000 cubic feet per second at Greens Bayou, and continue with this capacity to the canal outlet on San Jacinto River. In this reach from Greens Bayou to San Jacinto River, the channel section would have the same bottom width, side slopes and slope protection as proposed for the reach from White Oak Bayou to Halls Bayou. The increased capacity would result from the increase in the slope of the bottom profile from Greens Bayou to the canal outlet near the San Jacinto River. The velocity in this reach of the canal would be about 16 feet per second.

36. Details of the canal inlet on White Oak Bayou are shown on

Plate 54. Typical canal sections and paving details are shown on Plates 58 to 61, inclusive. The derivation of the economic sections proposed on this canal is included in the appendix, "Bases of Design".

37. At the canal crossing at Halls Bayou, the south bank would consist of a concrete paved earth embankment with crest at design storm water surface in the canal. All run-off produced on the Halls Bayou watershed above the canal by large storms such as the 1935 storm transposed and increased by 50 percent would be diverted down the canal. Under all conditions, up to and including design storm conditions, the capacity of the canal would be sufficient to divert practically all of the discharge produced on Halls Bayou watershed and very little overflow would be passed downstream into Halls Bayou channel. The plan and sections of the canal crossing at Halls Bayou are shown on Plate 55.

38. The canal crossing at Greens Bayou would consist of a concrete paved overflow crest on the downstream or south side of the canal, similar to that proposed for Halls Bayou. This overflow section is designed to pass a portion of those flows that exceed the design capacity of the canal into the channel of Greens Bayou below the canal. The plan and sections of this crossing are shown on Plate 56.

39. The outlet works of the North Canal are located at the west bluff line of the San Jacinto River and discharge into the Ingrando Marsh. Flows from this weir would pass over marshland and

into shallow sloughs to reach the river. The water in following these circuitous paths would be forced to drop any silt loads that had been picked up on the White Oak Bayou, Halls Bayou and Greens Bayou watersheds.

40. The spoil piles along the North Canal would be broken at intervals of 1,000 feet or less, to avoid trapping any surface water. At the stream crossings, it is proposed to haul the spoil material to locations outside the limits of overbank flow. The canal would be paved for its entire length which would permit it to drain freely at all times, thus eliminating the possibility of stagnant pools during dry seasons.

41. The I.G.N. and B.S.L. & W. lines of the Missouri Pacific Railroad and the T. & N.O. of the Southern Pacific cross the proposed route of the canal. U. S. Highway 75, State Highway 35, Hacker Road (to be adopted as state highway in near future and has no identifying number to date) and seven improved and six unimproved county roads, cross the route. Crossings for the railroads, the improved federal, state, and county highways, and three of the secondary roads would be required. Typical details of the proposed bridge crossings are shown on Plates 146 to 150, and are discussed in the appendix "Bases of Design".

42. The rights-of-way which would be required for the bridges and stream-crossing structures, together with the canal and spoil areas, total about 2,657 acres. It is proposed to acquire the surface rights to this land in fee simple, excepting a subordinate

right-of-way easement for railroad and highway purposes. The costs of construction contained in the report are based on construction carried out by government contract. It may be to the advantage of the government to grant easements to the railroad companies and highway departmentsto permit them to construct and maintain these bridges; however, this question will be determined prior to actual work, and for cost purposes, should not require additions to the estimates as shown. The land along the route from White Oak Bayou to Greens Bayou is being developed rapidly into small farm tracts, subdivisions, and residential and garden plots. Land values are increasing accordingly. The land that would be required for the canal from Greens Bayou to the San Jacinto River is undeveloped and is relatively inexpensive.

43. The proposed levee, north of Katy, Texas, is needed to prevent overflow into the Buffalo Bayou basin from the Mound Creek and Cypress Creek basins. It is proposed to construct this levee to an average height of about 12 feet, equivalent to elevation 180 M.S.L., at the beginning or west end of the levee, continue with this crest elevation for a distance of about 1800 feet, and then reduce the height of crest uniformly to elevation 156 on the east end. Compacted earth fill is proposed, with 1 on 3 side slopes and crown width of 10 feet. The location of this structure and typical cross-sections are shown on Plates 62 to 65, inclusive. The structure as shown would have a length of about 78,650 feet. The design proposed is for cost estimating purposes only, but the height of this levee

can not be reduced materially without subjecting it to the danger of being overtopped under design storm conditions. The excessive costs of this embankment indicate that it may be more practicable to supply additional storage in the proposed Addicks reservoir on South Mayde Creek to accommodate the overflow from the Mound Creek and Cypress Creek basins.

44. The proposed twin reservoirs on Buffalo Bayou and tributaries near Addicks, Texas, are to be formed by impervious, rolled, earth-fill dams, hereinafter known as the Addicks Dam and the Barker Dam. Locations of these embankments and reservoir areas are shown on Plate 66. Crown widths of 15 feet are proposed on these embankments. Slopes of 1 on 3 are proposed on both upstream and downstream sides for the upper 20 feet and slopes of 1 on 4 for the sections below. Typical sections of these embankments are shown on Plates 85 and 110.

45. Addicks Dam, the structure which would be constructed north of State Highway 73 (Katy Road), would have a height of about 35 feet at the maximum section. The overall length of the embankment would be about 54,862 feet. For 37,620 feet of this length, the height would not exceed 20 feet. The embankment would have a crest elevation 115.0 M.S.L. for its entire length, but between stations 54/00 and 465/00, a parapet 2½ feet in height is proposed to provide added protection against wave action under design storm conditions. It is proposed to protect the upstream face of the embankment with three inches of articulated concrete paving between

crest elevation 115.0 and elevation 98.0, or to ground surface from station 52/00 to station 490/00. Riprap is not available at the site of the work, and it can not be shipped in by rail and rehandled economically.

46. The outlet works through Addicks Dam at South Mayde Creek would consist of six precast concrete culverts 8 feet in diameter. Two of these culverts, added to decrease the emptying-time of the reservoir, would be equipped with control gates and would not be used until it had been established that the storm peak had passed.

47. Details of these outlets are shown on Plates 86 and 87. A conduit is proposed at Turkey Creek to provide drainage for the sump area that would be formed by the dam. This outlet would consist of concrete head walls, and precast concrete pipe 3 feet in diameter provided with seep rings. (See Plate 88). Some channel enlargement and rectification work would be necessary on South Mayde Creek below the outlet works, as shown on Plate 113.

48. At Barker Dam, the embankment, which would be constructed south of State Highway 73 (Katy Road), would have a height of about 37 feet at the maximum section across Buffalo Bayou. The overall length of the embankment would be about 72,844 feet, but for 69,930 feet of this length, the height would not exceed 20 feet. A crest elevation of 109.0 feet above mean sea level is proposed for the entire length of the structure, but between station 150/00 and station 680/00, a parapet 2½ feet in height is proposed to provide added protection against wave action under design storm condition. It is

proposed to protect the upstream face of the embankment with three inches of articulated concrete paving between crest elevation 109.0 and elevation 92.3, or to ground surface from station 125+00 to station 700+00. As previously stated in connection with Addicks Dam, riprap is not available at the site of the work, and it can not be shipped in by rail and rehandled economically.

49. The outlet works through Barker Dam at Buffalo Bayou would consist of seven precast concrete culverts, 8 feet in diameter. Two of these culverts would be equipped with control gates and would normally be closed during storm periods. The two-gated openings are proposed as spares and will aid in emptying the reservoir in a manner similar to the gates at Addicks Dam. Details of these outlet facilities are shown on Plates 111 and 112. Channel enlargement and rectification would be necessary on Buffalo Bayou below the dam to provide the necessary channel capacity to discharge the releases from this reservoir.

50. The plans, profiles and logs of borings for the Addicks Dam are shown on Plate 69, and for Barker Dam on Plate 89. Results of laboratory tests of typical samples of foundation and embankment materials are shown on Plates 70 and 71 for the Addicks Dam and on Plates 90 and 91 for Barker Dam. Detailed topography of the dam sites is shown on Plates 72 to 84 and 92 to 109, inclusive. A discussion of foundations and borrow area materials for these dams is included in the appendix, "Bases of Design".

51. The pool elevations that would obtain in both the proposed

Addicks and Barker Reservoirs by the 1935 storm, by the 1935 storm increased 50 percent, and by the design storm are shown in Table III, following. In the determination of these elevations, the storms were centered over each reservoir.

TABLE III

POOL ELEVATIONS - ADDICKS AND BARKER RESERVOIRS

Reservoir	Pool Elevations in Feet above Mean Sea Level			
	1935 Storm	1935 Storm + 50%	Design Storm	Design Storm (all conduits blocked)
Addicks	101.4	105.4	108.3	112.1
Barker	95.3	98.8	101.7	106.5

52. The maximum storage produced by the design storm in Addicks Reservoir, with four conduits open, would be 134,000 acre feet, equivalent to a run-off of 18.7 inches from the 134 square miles above that dam. The maximum storage produced by the design storm in Barker Reservoir, with five conduits open, would be 136,000 acre feet, equivalent to a run-off of 16.6 inches from the area of 152.8 square miles above Barker Dam. The proposed crest elevations of 115.0 M.S.L. on Addicks Dam and 109.0 M.S.L. on Barker Dam would provide 6.7 feet and 7.3 feet of freeboard to the top of embankments, respectively, above the pools produced by the design storm. An additional 2½ feet of freeboard would be provided for the higher por-

tions of these structures by the proposed parapets.

53. A pipe line of the Texas and New Mexico Oil Company crosses the proposed site of the Addicks Dam as shown on Plate 68. Likewise, a pipe line of the Shell Pipe Line Company crosses the proposed site of the Barker Dam and reservoir area. It would be necessary to relocate these lines outside of these dam sites and reservoir areas. There are neither railroads nor state and federal roads in the proposed dam sites or reservoir areas, but 3 improved and 7 dirt, county roads would be flooded by the pools produced by the transposed 1935 storm or larger storms. It is proposed to construct one new road from Clay Road to Federal Highway 290 (Hempstead Road) and provide 13 ~~12~~ ramps over the embankments for existing roads as shown on Plates 67, 85 and 110.

54. It is proposed to acquire lands in Addicks and Barker Reservoirs to an elevation 3 feet above the pools which would be produced by the 1935 storm transposed over each watershed. Although the design of the embankments is based upon the design storm rainfall of 31.4 inches, the occurrence of such a storm in the basin can not be expected to occur more than once in the lives of these structures. The maximum storm of record in the basin was that of December 6-8, 1935, and it is expected that storms of similar intensities will occur several times during the lives of these structures. Consequently, it is considered unnecessary to acquire lands to the pool elevation which would be produced by the design storm. Acquisition to a taking-line, 3 feet above the computed pool elevations for the 1935 storm centered above each reservoir, is considered advisable, since

the savings in annual interest would be in excess of the probable damages from storms producing pools greater than the taking-line limits. In Addicks Reservoir, the limit of acquisition would be elevation 104.4 M.S.L., and the area would total 10,900 acres. In Barker Reservoir, the limit would be elevation 98.3 M.S.L. and the total 13,050 acres. It is proposed to purchase this land in fee simple, but in some instances, the purchase of surface rights, exclusive of mineral rights, would afford a saving.

55. Much of the land in these reservoir areas is suitable for grazing of cattle, and is being used for that purpose now. It is probable that, if these lands were acquired by the Government, arrangements could be made for the leasing of large sections for grazing purposes. Such a lease would carry with it certain risks which would tend to reduce the price; nevertheless, inquiries already have been made of this office as to the availability of these lands for this purpose.

56. Except for a reach of 10,500 feet above the entrance of the South Canal, the natural channels of Buffalo Bayou and South Mayde Creek are insufficient to accommodate the regulated outflow from the reservoirs. Although the rectification of these channels would not be advisable unless the South Canal were constructed, since it would increase the rate of concentration of flows from the area below the reservoirs, and thus increase flood flows in the city, the emptying period of the reservoirs for large floods may be as long as 17 days, and such rectification is considered to be de-

sirable when the South Canal is constructed.

57. The general plan of the proposed rectification and enlargement is shown on Plates 113 and 114. It consists of enlarging the channel to a bottom width of 15 feet and increasing the depth as much as 25 feet, with 1 on 3 side slopes, where the channel is of inadequate size. It will also be necessary to clear the channel in the lower reach where no enlargement is necessary to improve its hydraulic characteristics. Cut-offs will be made where economical, and as much material will be wasted in the abandoned channel as is possible. Spoil piles will be set back 25 feet from the top of cut and limited to 15 feet in height, with 1 on 2 slopes. No soils investigations have been made in the proposed work area, but the general nature of the soils is the same as those encountered in the greater portion of the basin, and they present no particular difficulty in excavating.

58. The proposed interception dam, on Buffalo Bayou to divert flood flows to the South Canal, would be located about 8.4 channel miles below the Barker Reservoir outlet works and about 7.7 channel miles west of the city limits of Houston, Texas. The general location of this structure is shown on Plates 115 and 120. An impervious, earth-fill, non-overflow structure is proposed with crest at elevation 77.0. A conduit is proposed through this dam for passing low flows down Buffalo Bayou for flushing purposes in accordance with the desires of local interests. During severe floods, the uncontrolled area below the Addicks and Barker Dams, together with the

outflow from these reservoirs, will exceed the capacity of the South Canal for a comparatively short time. It would be necessary to discharge this excess down the Buffalo Bayou channel. A spillway for passing these excessive flows is proposed near the site of the dam as shown in detail on Plates 115 and 118. Details of the inlet to the South Canal are shown on Plates 115 and 118.

59. The proposed South Canal would have its beginning at the Interception Dam on Buffalo Bayou, cross Brays Bayou below the mouth of Kegans Bayou, southwest of Bellaire, Texas, intercept Sims Bayou north of Almeda, Texas, pass south of Aykawa, Texas, and then continue almost due east to Galveston Bay near Red Bluff. The canal would lie entirely within Harris County, as shown on Plate 119. The plan, profile and logs of borings are shown on Plates 120 to 134, inclusive.

60. The design capacity of this canal from Buffalo Bayou to Middle Bayou is 15,000 cubic feet per second, with a water surface from 2 to 16 feet below natural ground, and a depth of water of about 21.7 feet. In this reach, the channel section would have a bottom width of 30 feet, and 1 on 2 side slopes paved with four inches of reinforced concrete to three feet above the design water surface. From Middle Bayou to the canal outlet at Galveston Bay, the design capacity of the canal is 21,000 cubic feet per second. This additional capacity is obtained by increasing the width of the canal.

61. Across Brays Bayou, the left bank of the South Canal would

consist of a concrete-paved earth embankment, designed to serve as an overflow section. Under all storm conditions, a large portion of the flood flows in Brays Bayou would be diverted into the canal by this structure. Plan and sections of this crossing are shown on Plate 135.

62. Similar structures, designed to discharge a portion of the peak flows of these streams down their natural channels when the canal is discharging at full capacity, are proposed at Willow Waterhole, Sims, Turkey Creek, Middle and Taylor Bayous. Plans and sections of these structures are shown on Plates 136 to 140, inclusive, in the sequence listed.

63. Three T. & N.O. lines of the Southern Pacific Railroad, the I.-G.N. of the Missouri Pacific, the G.C. & S.F. of the Santa Fe and the G.H. & H. line of the Missouri, Kansas and Texas and the Missouri Pacific railroads cross the proposed route of the South Canal. U.S. Highways 75 and 90, State Highways Nos. 19, 35, and 146, and 6 improved and 16 unimproved county and private roads cross the route. Crossings for the six railroads, the federal, state, and county roads, and 13 unimproved roads would be required. Five roads would be relocated. Crossings for electric power lines, telephone and telegraph lines and cables, and crude oil and gas lines would be required. Locations of the bridge and utility crossings are shown on Plates 120 to 134 and 151. Details of the proposed crossing structures are shown on Plates 146 to 150, inclusive.

64. The rights-of-way which would be required for the bridges,

the stream-crossing structures, together with the canal and spoil areas, total about 4,388 acres. It is proposed to acquire the surface rights to this land in fee simple, excepting a subordinate right-of-way easement for railroad, highway, and utility purposes.

65. The removal of existing obstructions to, and encroachments upon, the stream channels within the city of Houston are the responsibility of local interests and this work must be carried out at their sole expense as provided in House of Representatives Document No. 456, 75th Congress, 2nd Session. The total cost of this work is shown in detail in the cost estimates for the Project Plan, in the appendix "Cost Data".

a. The Preston Avenue Bridge (see Plate 156) lies in the section of concrete-lined channel extending from the upstream end of Farmers' Market to Smith Street. The inadequate opening of the Preston Avenue Bridge decreases the effectiveness of this lined channel. This bridge must be replaced.

b. The restricted area at Franklin Avenue (see Plate 156) is the result of deliberate encroachment upon the stream channel and should be opened as soon as possible. The necessary work would consist of excavation on the left bank and the removal of the old Hamilton Hotel on the right bank. The removal of the hotel is now in progress.

c. The existing Milam Street Bridge (see Plate 156) is a serious obstruction to flow and is in a dangerous condition as a result of damage inflicted by the 1935 flood. It should be removed

and replaced by a structure with greater flood clearance.

66. The city water works pumping plant, located in the Buffalo Bayou flood plain above the mouth of White Oak Bayou, is the most important structure in this reach of the bayou. A retaining wall or levee on three sides of the station would be required to protect it.

67. A program of work entailing the expenditure of approximately $2,453,000 of Works Progress Administration funds for the improvement of drainage in Harris County and for flood control work in Houston has been submitted to this office by the Harris County Flood Control Authority. Issuance of bonds by this Authority to finance its participation in this program has been delayed, pending the approval of the Attorney General of the State of Texas. This program as outlined was discussed in departmental correspondence dated January 16, 1939, to the Division Engineer, Subject: "Proposed combined project of flood control and drainage works submitted by Harris County Flood Control Authority to W.P.A. and to the Galveston U. S. Engineer Office". This W.P.A. program includes the work of removing existing obstructions and encroachments set forth in paragraph 65. It also includes the protection of the city water works pumping plant.

68. Cost Estimate Summary.- The cost of all of the work proposed in the definite project plan is shown in the following cost summary:

DEFINITE PROJECT REPORT
SUMMARY OF COSTS

No.	Item	A. Construction	B. Removal of Obstructions	C. Reconstruction and Relocation	D. Rights-of-way	Total
1.	White Oak Dam and Reservoir	$ 502,600.	None	$ 578,000.	$ 1,473,400.	$ 2,554,000.
2.	Brickhouse Gully Bypass	69,900.	None	12,400.	23,400.	105,700.
3.	North Canal	5,765,800.	None	898,500.	451,000.	7,115,300.
4.	Cypress Creek Levee	611,700.	None	22,100.	49,700.	683,500.
5.	Addicks Dam and Reservoir	1,797,700.	None	147,200.	1,337,700.	3,282,600.
6.	Barker Dam and Reservoir	1,995,900.	None	246,800.	1,399,200.	3,641,900.
7.	Rectification, Addicks and Barker Dams to South Canal	610,300.	None	58,400.	196,800.	865,500.
8.	Interception Works, South Canal	422,000.	None	None	38,500.	460,500.
9.	South Canal	10,239,300.	None	1,488,900.	1,329,700.	13,057,900.
	Sub-total	$ 22,015,200.	None	$ 3,452,300.	$ 6,299,400.	$ 31,766,900.
10.	Buffalo Bayou, City Limits to Main Street	None	$ 228,500.	None	None	228,500.
	Grand Total	$ 22,015,200.	$ 228,500.	$ 3,452,300.	$ 6,299,400.	$ 31,995,400.
	Borne by United States	$ 9,000,000.	None	$ 3,452,300.	$ 6,299,400.	$ 18,751,700.
	Funds supplied by Local Interests (Includes work shown Item 10)	$ 13,015,200.	$ 228,500.	None	None	$ 13,243,700.

NOTE: The costs shown above include an allowance of 15% for Engineering and Contingencies for costs listed under A, B, and C, and 20% for costs listed under D.

Cost estimates in detail are shown in the appendix, "Cost Data". The unit costs used in the preparation of these estimates are discussed in that appendix. The estimates of unit costs for large items of construction, such as excavation and fill by dragline, are based on information obtained from a number of contractors experienced in these classes of work in the State of Texas and adjoining states. For costs relative to the construction of outlet structures, concrete paving and the like, dealers' prices for materials were used as the base cost; and freight, handling, hauling, placing charges, and contractor's overhead were added.

69. Economic Study.- Protection, in accordance with the project plan as proposed, would cost the Federal Government about $18,752,000 and local interests about $13,244,000 including the W.P.A. funds that are to be expended for the removal of obstructions and encroachments and for construction work along Buffalo Bayou within the city.

70. The peak flows, which would be produced with a recurrence of the 1935 (Westfield) storm, the 1955 storm plus 50 percent, and the design storm, the latter two storms centered in their most unfavorable position below the twin reservoirs on Buffalo Bayou, with all features of the plan in operation, are shown for critical points in the channels in Houston, Texas, in Table IV, following:

TABLE IV

PEAK FLOWS WITH PLAN IN OPERATION

Location	Peak Flows in C. F. S.		
	1935 Storm	1935 Storm +50%	Design Storm
White Oak Bayou above Little White Oak Bayou	2,600	7,400	8,500
White Oak Bayou at mouth	5,600	14,800	17,500
Buffalo Bayou above White Oak Bayou	8,400	19,500	24,300
Buffalo Bayou below White Oak Bayou	13,600	32,800	40,700

71. As stated in paragraphs 3 and 4 of this report, local interests have agreed that the Cypress Creek Levee, Addicks and Barker reservoirs on Buffalo Bayou, White Oak Reservoir and the North and Central canals should be constructed first, and they have given assurances that they will have available and will furnish the funds required for the construction of these items in excess of the nine million dollars ($9,000,000) construction costs to be borne by the Government. With this first stage of construction in operation, the peak flow in Buffalo Bayou below the confluence of White Oak Bayou would be, with a recurrence of the 1935 storm, 24,300 cubic feet per second. The peak flow for a 1935 storm plus 50 percent storm would be 36,400 cubic feet per second. The peak flow with the design storm centered in its most unfavorable position would be 50,000 cubic feet per second.

72. Construction of all items of the Project Plan, except the South Canal and its interception dam on Buffalo Bayou, at a cost to local interests of about $1,972,200, would afford protection against large storms such as the 1935 storm or the 1935 storm increased 50 percent. The last-mentioned storm, centered in its most unfavorable position below the twin reservoirs on Buffalo Bayou, may produce bankful stages with minor overflows in the bayou channels within the city. The North Canal, under this storm condition, would intercept the run-off production on Halls Bayou and Greens Bayou watersheds and divert it away from Buffalo Bayou to the San Jacinto River, in addition to discharging the flow from White Oak Reservoir. For lesser storms, drainage conditions along the route of the proposed North Canal would be benefited, materially. However, the first stage construction of the project plan would necessitate discharging the regulated flow from Addicks and Barker reservoirs through the city of Houston, Texas, and into the turning basin and Houston Ship Channel.

73. The second or final stage of construction for the ultimate plan would include the construction of the South Canal and the Interception Dam on Buffalo Bayou. This construction would divert to Galveston Bay, near Red Bluff, the regulated flow from the twin reservoirs, and, as proposed, would afford protection against the maximum probable (design) storm. From the Federal viewpoint, the flood control benefits which it would afford are not commensurate with the cost. However, Federal participation in this work would be small, as local interests would be required to shoulder all costs except for

rights-of-way and reconstruction items. Moreover, local interests contend that the South Canal is economically feasible, because of its many advantages with respect to local drainage problems, and because it would eliminate the prolonged periods of undesirable velocities in the turning basin due to the early release of storage from the twin reservoirs. In addition, it would reduce the flood flows in Brays and Sims Bayous.

74. Local Cooperation.- The Harris County (Texas) Flood Control District was created and established legally by the Forty-Fifth Legislature of Texas, 1937, (H.B. 1131, approved May 15, 1937. See Title 128, Chapter 8, Vol. 21, Vernon's Annotated Revised Civil Statutes of Texas). Under this Act, the District has power and authority to meet all the requirements of local cooperation set forth in House Document 456, 75th Congress of the United States, as adopted and authorized by River and Harbor Act approved June 20, 1938, and as amended by Section 3a, Chapter 699, Public No. 396, 76th Congress, 1st Session (H.R. 6634) approved August 11, 1939.

75. The Harris County Flood Control District has power under the law which created it to derive plans and construct works to lessen and control floods, to prevent deposit of silt in navigable streams, to remove obstructions, natural or artificial, from streams and water courses, to regulate the flow of surface and flood waters, to cooperate with and contract with the United States of America or with any of its agencies now existing, or which may be created hereafter, for grants, loans, or advancements to carry out any of the purposes

set forth in this Act and to receive and use said moneys for such purposes; or to contribute to the United States of America or any of its agencies in connection with any project undertaken by it affecting or relating to flood control in Harris County; to cooperate with, or to contract with, the city of Houston, or any adjacent county, or any agency or political subdivision of the State, or any city or town within Harris County in relation to surveys, the acquisition of land or rights-of-way, the construction or maintenance of projects or parts thereof or the financing of the same in connection with any matter within the scope of this Act; to do any and all other acts or things necessary or proper to carry into effect the foregoing powers.

76. The Harris County Flood Control District has legal financial ability to meet its responsibility of cooperation by the issuance of bonds under authority of the Harris County Flood Control Act, S.B. No. 6, approved May 8, 1939, 46th Texas Legislature, which provides for the issuance of bonds by Harris County, Texas, to finance the flood control project and to pay for said bonds from taxes donated by the state or from Harris County general fund. Before such bonds may be sold, the Attorney General of the State must approve them. It is understood that he has refused to approve the bonds for the W.P.A. program of work referred to in paragraph 67, because he believes that the tax donation to Harris County Flood Control District is unconstitutional. There is suit now pending in the State Supreme Court in which Harris County seeks the Attorney Gen-

eral's approval of these bonds. However, if the tax donation law is declared unconstitutional, the Flood Control District can operate under the 1937 law under which it was created and issue bonds and levy taxes to pay for them.

77. On January 27, 1939, the Secretary of War of the United States accepted and approved the resolution adopted June 29, 1938, by the Harris County (Texas) Flood Control District giving assurances that local interests will comply with the terms of local cooperation required in connection with the improvement of Buffalo Bayou and its tributaries, Texas, House Document 456, 75th Congress, 2nd Session, authorized by the River and Harbor Act approved June 20, 1938. This approval is still in effect as Section 3a, Chapter 699, Public Law No. 396, 76th Congress, 1st Session (H.R. 6634) approved August 11, 1939, did not add to but eliminated some of the requirements of local cooperation.

78. As quoted previously in paragraph 67, the Harris County Flood Control District has agreed by resolution passed and approved May 6, 1940, by the Commissioners' Court of Harris County, Texas, to have available and furnish such funds for the construction of the items included in the first-stage construction of the project plan, as may be required from the local authority in excess of the nine million dollars ($9,000,000) construction cost to be borne by the Government.

79. Time Required for Construction.- The ultimate project, including the South Canal and the South Canal Interception Dam, could

be constructed in a five-year period, contingent on the availability of funds from the Government and the Local Authority. The rapid development of properties along the proposed route of the North Canal, the proposed relocation of the Burlington-Rock Island Railroad, and the White Oak dam site and reservoir area indicates the desirability of initiating land acquisition for these construction items in the order mentioned, immediately as the funds are made available. However, since the twin reservoirs, Addicks and Barker, would afford the greatest protection of any of the items in the project plan, actual construction should be initiated and completed on these reservoir dams, first. Normal weather conditions would permit the construction of any of the items in the ultimate plan during twelve months of the year. A tentative construction schedule, showing approximate quantities and costs by construction years, is shown on Plate 160.

80. Recommendations.- I recommend that the plan, which has been proposed and developed in this report and the appendix "Bases of Design", and which is shown on the inclosed drawings, be adopted as the definite project plan and that I be authorized to prepare detailed construction plans and proceed with the work preliminary to acquisition of the necessary rights-of-way.

F. S. Besson,
Colonel, Corps of Engineers,
District Engineer.

Inclosures:
Appendix - Bases of Design
Appendix - Cost Data
Appendix - Folio of Plates